The Stella Group, Ltd.

The Stella Group, Ltd.. is a strategic technology optimization and policy firm for clean distributed energy users and companies which include advanced batteries and controls, energy efficiency, fuel cells, geoexchange, heat engines, microhydropower (including tidal and wave), modular biomass, photovoltaics, small wind, and solar thermal (including CSP, daylighting, water heating, industrial preheat, building air-conditioning, and electric power generation). Scott Sklar serves as Steering Committee Chair of the Sustainable Energy Coalition, composed of the renewable and energy efficiency associations, national environmental groups, and analytical groups, and sits on the national Boards of Directors of the non-profit Business Council for Sustainable Energy and The Solar Foundation, teaches two unique interdisciplinary sustainable energy course at The George Washington University, Scott Sklar was awarded the prestigious The Charles Greely Abbot Award by the American Solar Energy Society (ASES) and on April 26, 2014 was awarded the Green Patriot Award by George Mason University in Virginia, and serves on the US Department of Commerce Renewable Energy & Energy Efficiency Advisory Committee, term ending June 2020.

The Stella Group, Ltd. 706 North Ivy Street, Arlington, VA 22201

703-522-3049 www.TheStellaGroupLtd.com solarsklar@aol.com

RESILIENCY and RELIABILITY

RESILIENCY

Resiliency encompasses consequences to the electricity system and other critical infrastructure from high-impact external events whose likelihood was historically low, but is now increasing.

RELIABILITY

Maximize electric power 24 hour operations – Minimize outages

Reliability is generally measured in terms of the system average duration and frequency of outages (SAIDI and SAIFI), with different permutations based on whether the system average or customer average is more important to the reliability regulator.

System Average Interruption Frequency Index (SAIFI)

SAIFI is the average number of sustained interruptions per consumer during the year. It is the ratio of the annual number of interruptions to the number of consumers.

SAIFI = (Total number of sustained interruptions in a year) / (Total number of consumers)

System Average Interruption Duration Index (SAIDI)

SAIDI is the average duration of interruptions per consumers during the year. It is the ratio of the annual duration of interruptions (sustained) to the number of consumers. If duration is specified in minutes, SAIDI is given as consumer minutes.

SAIDI = Total duration of sustained interruptions in a year / total number of consumers

All my projects for 18 years revolve around these market drivers --

The driver for energy storage has been fourfold:

1. Dedicated to critical circuits for absolute power quality (preventing surges sags, transients) and/or frequency control as the distribution grid ages and becomes more fragile

2. Dedicated to critical functions for absolute electric power reliability to insure communications, internet, manufacturing controls, security, signage, etc.

3. Arbitraging higher electricity sub-rates (expressed as demand charges, peak & seasonal power rates, and in some states spot/ratchet rates)

4. Solely power critical infrastructure with charging inputs by on-site renewable energy for cellular towers, data centers, monitoring systems, signal lights (railways, roadways, harbor ways, etc), pipeline pumps (water, sewage, fuels) first responders (police, fire, ambulance), hospitals & nursing homes, water & sewage treatment plants, airports of all sizes, and all sorts of security and sensing systems, etc.

SKLAR THESIS

BATTERY STORAGE MAKES ABSOLUTE ECONOMIC SENSE IF YOU CAN OFFSET THREE COST AREAS:

1. OFFSETTING EQUIPMENT DAMAGE AND REPLACEMENT COSTS FOR ELECTRIC POWER QUALITY EQUIPMENT ADDRESSING: SURGES, SAGS, and TRANSIENTS

2. PROVIDING ABSOLUTE ELECRIC POWER RELIABILITY FOR A SUBSET OF THE ELECTRIC LOAD – CRITICAL FUNCTIONS (ie. dedicated to a series of sub-circuits)

3. ARBITRAGING LOWER ELECTRIC RATES TO OFFSET HIGHER RATES and DEMAND CHARGE REDUCTION

BATTERY STORAGE: FOUR TRENDS –

SHORT TERM – power quality & arbitraging sub-rates

MEDUM TERM – resiliency & reliability – first play
critical shared infrastructure

But please note, these markets will not be penetrated by larger companies most likely. but more agile, smaller technology companies.

Five kinds of market focus –

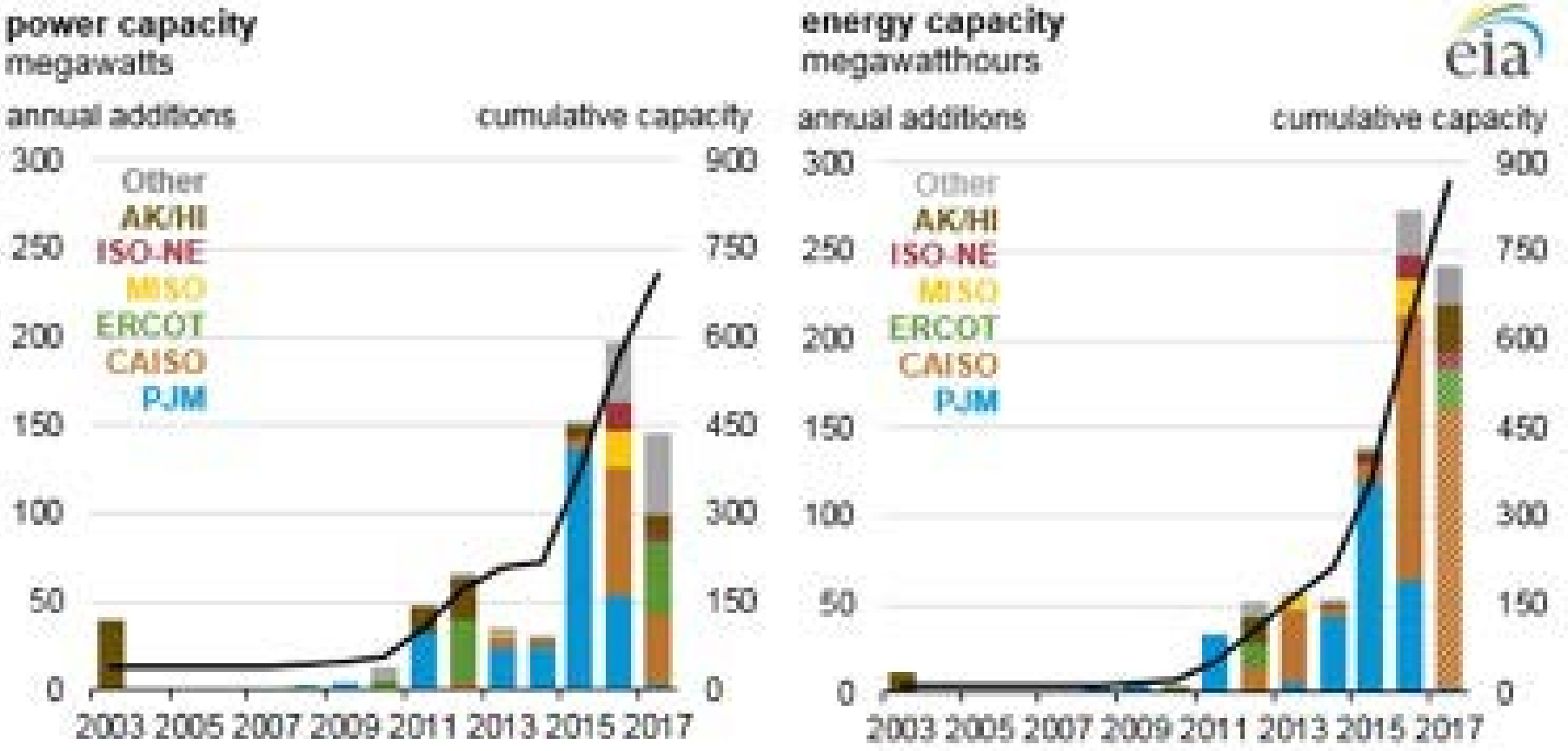
- utilities (slow, uneven, and state-based)
- commercial/industrial/institutional (my markets) **
- infrastructure (mostly on-site at towers, pumps, etc) **
- government – military & remote **
- residential (ie Tesla & Solar City, etc.)

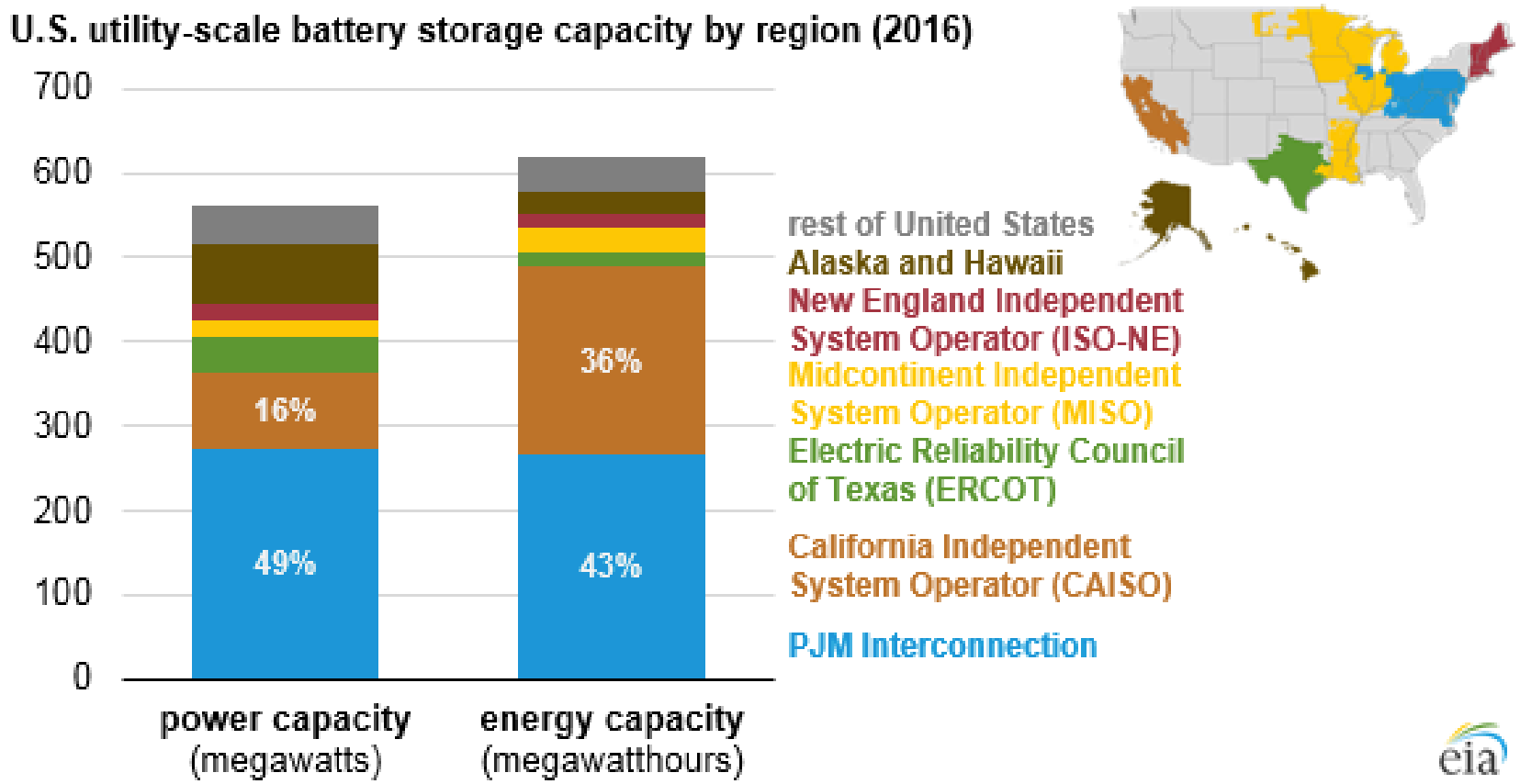
EAST SIDE

NET ZERO BUILDING #126 WASHINTON NAVY YARD (NAVFAC)

Mitigated 63,000kWh of electricity

Figure ES1. U.S. large-scale battery storage capacity by region (2003–2017)





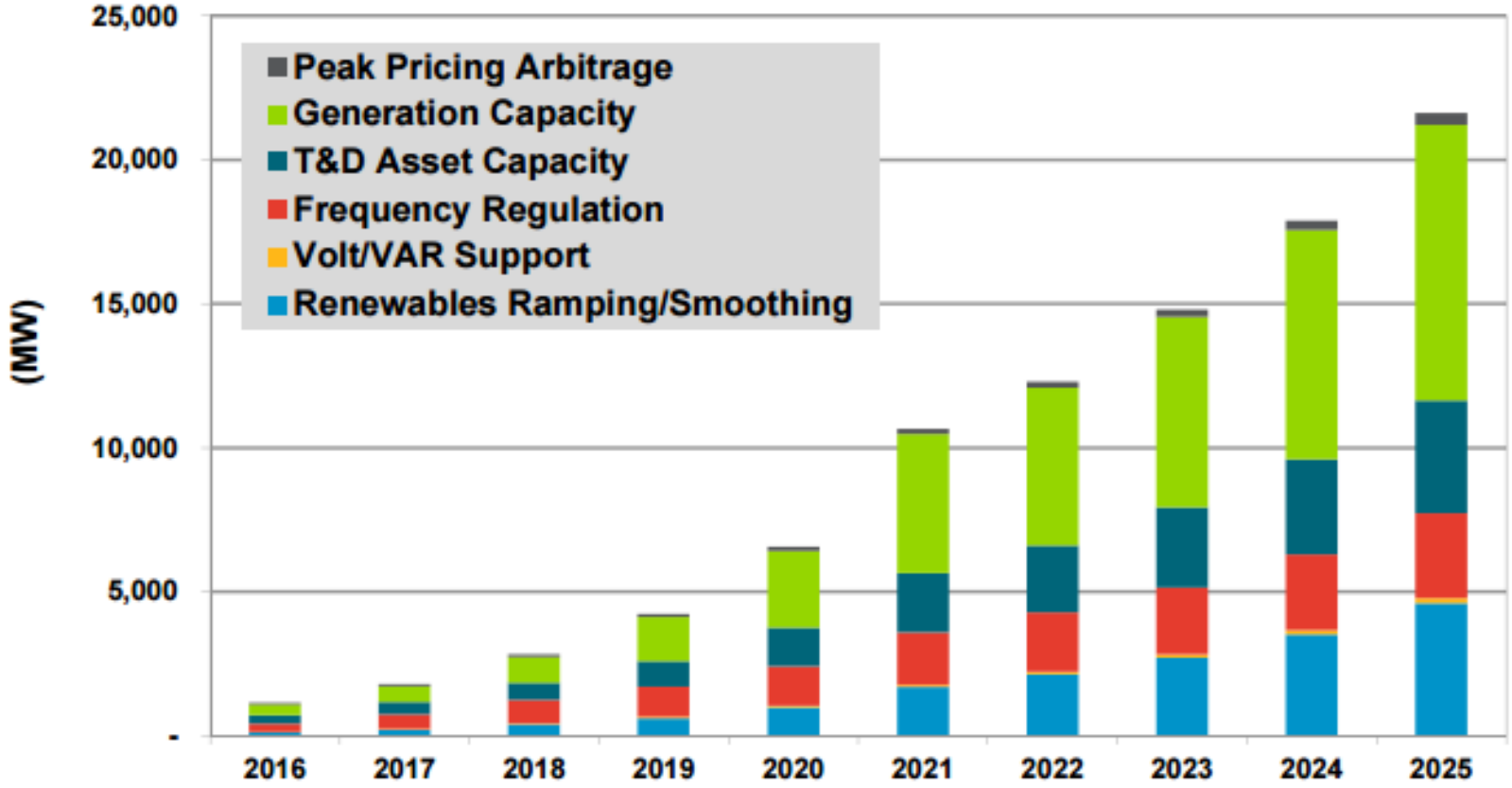
Morning Consult <morningconsult.com> Thursday, March 1, 2018 8:49 AM

RMI Report Finds Renewables, Storage Reaching Cost Parity:
UtilityDive.com, by Herman K. Trabish, June 11, 2018

https://www.utilitydive.com/news/end-of-the-gas-rush-renewables-storage-reaching-cost-parity-report-fin/524840

A report released by the nonprofit Rocky Mountain Institute, "The Economics of Clean Energy Portfolios," shows that emerging mixes of renewable energy, storage, and other distributed energy resources may soon be more cost effective than natural gas plants in most regions. RMI's modeling shows the portfolio of renewables, batteries, demand response and energy efficiency can replace natural gas plants and save ratepayers money. The problem is that developers engaged in a "rush to gas" have already planned $110 billion in gas plant investments by 2025. That trend could lock in $1 trillion in costs to the U.S. power sector by 2030 if it continues and make it more difficult for renewables and batteries to get a foothold in the market. The gas rush will likely continue if regulators and lawmakers do not provide new incentives and market rules to encourage battery storage and demand management, which will provide crucial flexibility in emerging clean energy portfolios.

Chart 1.1 Installed ESGAS Power Capacity by Application, World Markets: 2016-2025



(Source: Navigant Research)

http://www.utilitydive.com/news/ferc-proposed-storage-rulemaking-draws-familiar-concerns-over-jurisdiction/437022/

Energy Storage Power Conversion Systems Becoming a 'Crowded Market': Energy Storage News, by Andy Colthorpe, July 18, 2018

https://www.energy-storage.news/news/navigant-energy-storage-pcs-becoming-a-crowded-market

The market for power conversion systems (PCS) used in energy storage is becoming "increasingly crowded" with competitors, while the diverse field of players will contribute to "rapid technological innovations and price reductions," according to Navigant Research. Renewable energy sources producing DC power, such as solar PV, and variable AC (wind), use PCS to convert their energy to regulated AC power which can be grid-integrated, thus, "PCS enable the utilization of renewables, storage, and microgrids on a large scale". While North America is likely to see a higher capacity of energy storage installations in the next few years, all world regions are expected to see significant PCS growth over the 10-year forecast period.

Battery Storage, Smart Grid, and Energy Efficiency Companies Bring in $2.8 Billion in VC Funding in 2018:
North American Clean Energy, January 21, 2019

http://www.nacleanenergy.com/articles/33415/battery-storage-smart-grid-and-energy-efficiency-companies-bring-in-2-8-billion-in-vc-funding-in-2018

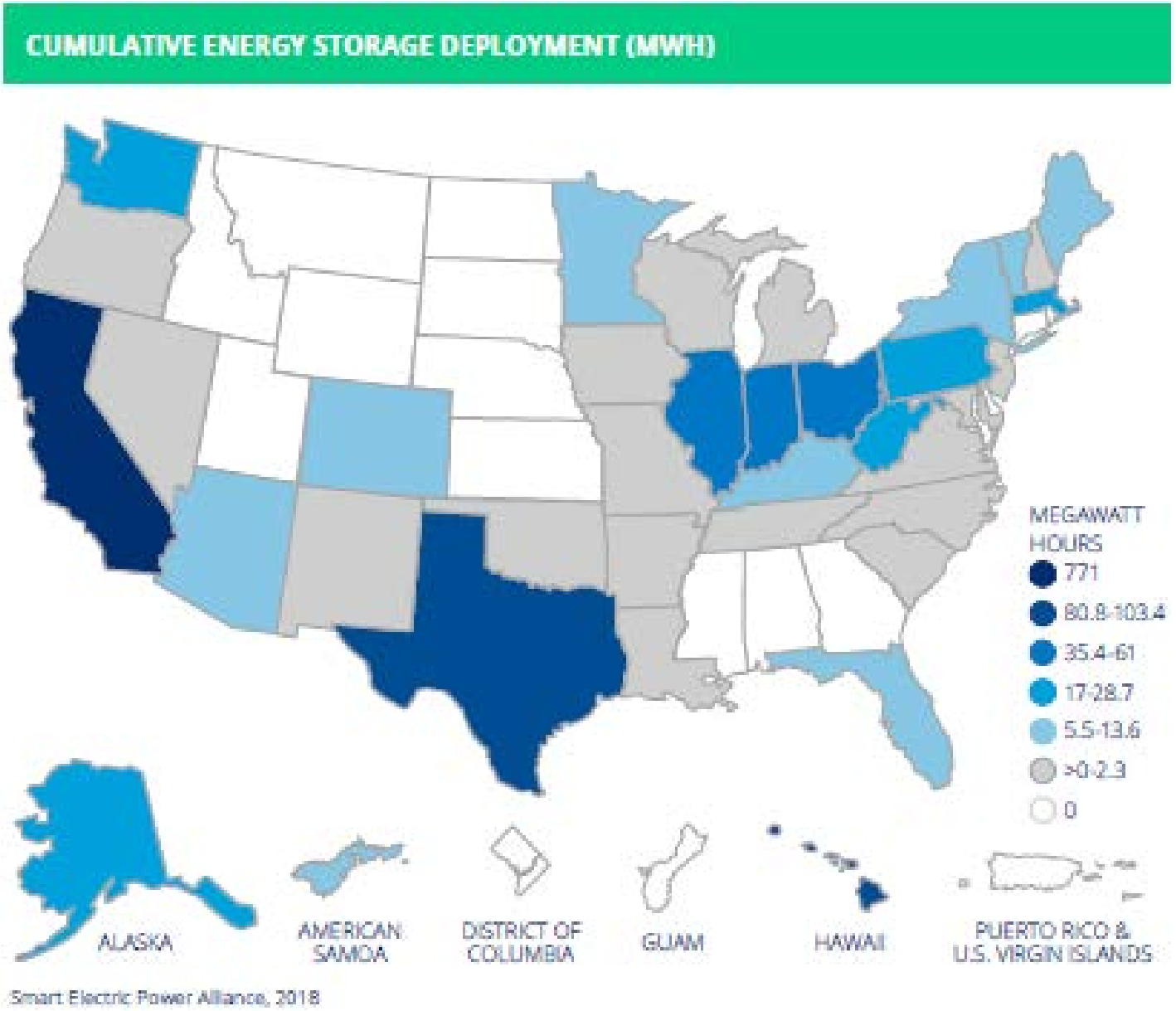
According to Mercom Capital Group, $2.8 billion was raised by Battery Storage, Smart Grid, and Energy Efficiency companies in 2018, an increase from the $1.5 billion raised in 2017. In 2018, VC funding into Battery Storage companies increased by 19 percent to $850 million in 49 deals compared to $714 million raised in 30 deals in 2017. Total corporate funding, including debt and public market financing, increased to $1.3 billion in 2018 compared to $890 million in 2017. Lithium-ion based battery technology companies received the most funding with $236 million. Smart Grid companies raised $530 million in VC funding in 29 deals in 2018, a 26 percent increase compared to the $422 million raised in 45 deals in 2017. VC funding for Energy Efficiency companies jumped to $1.5 billion in 23 deals in 2018 compared to $384 million in 38 deals in 2017. Total corporate funding, including debt and public market financing, reached more than $1.7 billion in 2018, compared to $3.3 billion in 2017.

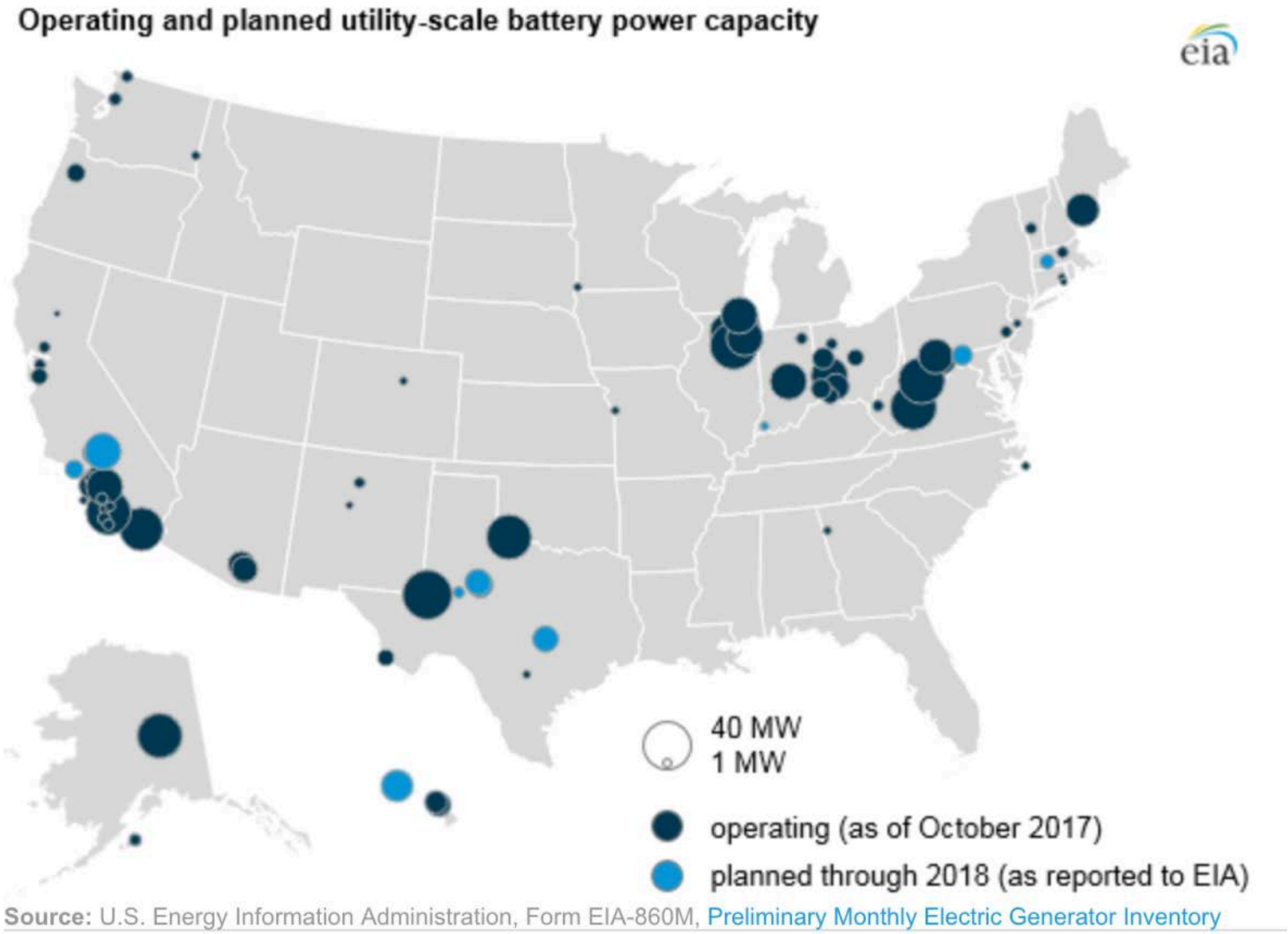
The U.S. Department of Energy's National Renewable Energy Laboratory and Clean Energy Group (CEG) have released the first comprehensive public analysis detailing the potential size of the commercial behind-the-meter battery storage market in the United States. NREL analyzed over 10,000 utility tariffs in 48 states, finding that more than five million of the 18 million commercial customers across the country may be able to cost-effectively reduce their utility bills with battery storage technologies. (September 2017)

These findings, grouped by utility service territory and state and illustrated in a series of maps and tables, are presented in NREL and CEG's white paper, Identifying Potential Markets for Behind-the-Meter Battery Energy Storage: A Survey of U.S. Demand Charges, available at this link:

(http://www.cleanegroup.org/ceg-resources/resource/NREL-demand-charges-storage-market/)

The researchers looked at the number of commercial customers eligible for utility rate tariffs that included demand charges of $15 or more per kilowatt, an industry benchmark for identifying economic opportunities for behind-the-meter storage and they concluded that nearly five million customers were at or above this demand charge threshold, accounting for over 25 percent of commercial customers in the United States. This represents a substantial market opportunity for behind-the-meter battery storage, which can be installed to control peak demand and lower electricity bills by reducing demand charges.

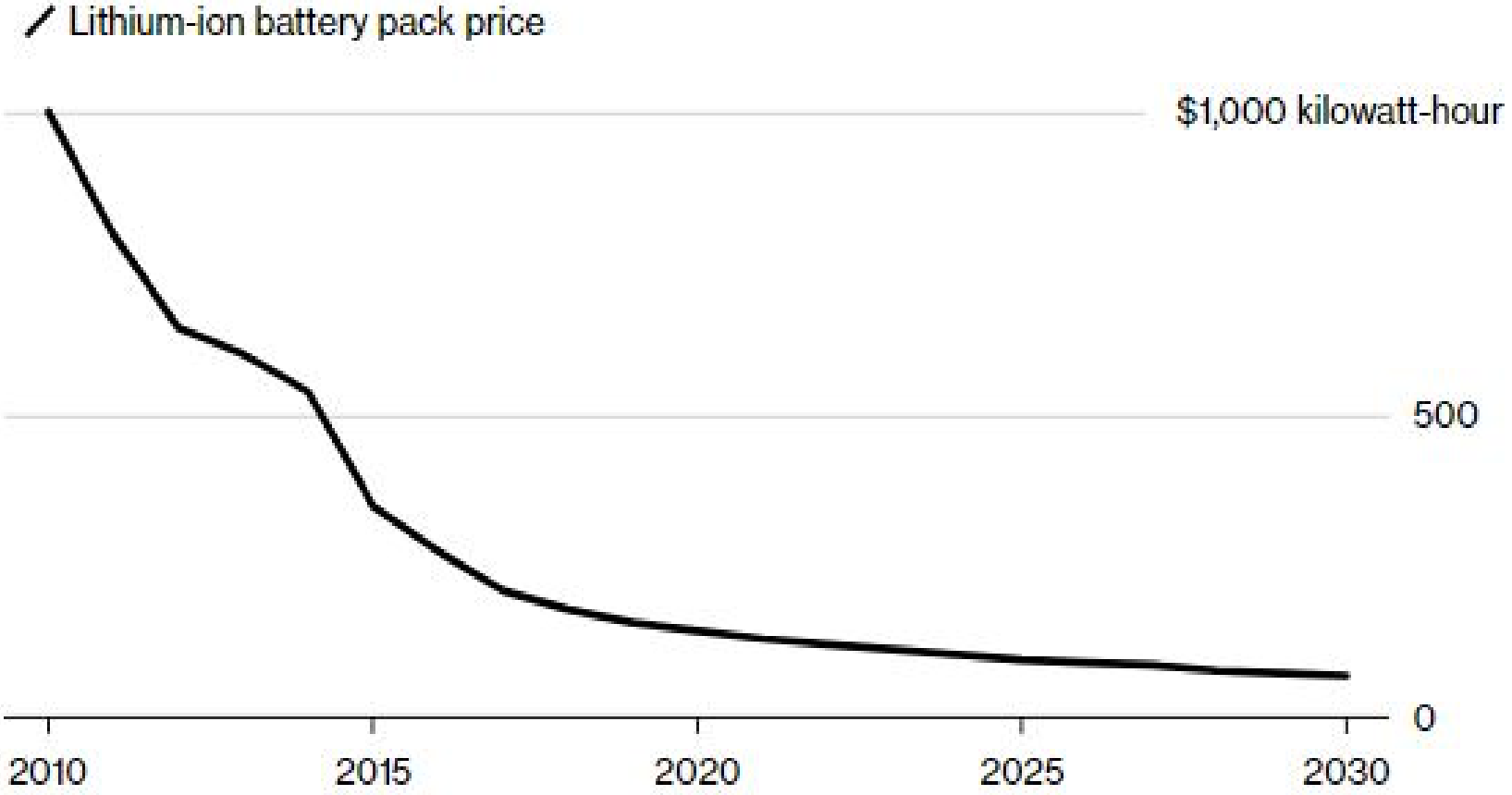

CUMULATIVE ENERGY STORAGE DEPLOYMENT (MWH)
MEGAWATT HOURS
771
80.8-103.4
35.4-61
17-28.7
5.5-13.6
>0-2.3
0
ALASKA
AMERICAN SAMOA
DISTRICT OF COLUMBIA
GUAM
HAWAII
PUERTO RICO & U.S. VIRGIN ISLANDS
Smart Electric Power Alliance, 2018



https://www.utilitydive.com/news/10-trends-shaping-the-power-sector-in-2018/515235/

Cheaper Batteries

Costs are expected to drop in half by 2025 as production ramps up



Source: Bloomberg NEF

Note: Prices starting in 2018 are forecasts

Solar With Batteries Cheaper Than Gas in Parts of U.S. Southwest:
Bloomberg.com, by Brian Eckhouse, September 17, 2018

https://www.bloomberg.com/news/articles/2018-09-17/solar-with-batteries-cheaper-than-gas-in-parts-of-u-s-southwest

Solar projects that incorporate storage are becoming cheaper to build per megawatt-hour in parts of the U.S. Southwest than new gas-fired generation, according to a new report by Bloomberg New Energy Finance. For example, a 100-megawatt solar farm that goes into service in Arizona in 2021, coupled with a 25-megawatt storage system with four hours of capacity, will be able to provide power for $36 a megawatt-hour, according to BNEF. That's well below the $47 price from a new combined-cycle gas plant. That positions solar to replace a significant portion of the 7 gigawatts of coal-fired power that's expected to retire in the region over the next decade.

Tucson Electric Power has signed a power purchase agreement for a solar-plus-storage system at "an all-in cost significantly less than $0.045/kWh over 20 years," according to a company official. Exact prices are confidential, but a release pegged the PPA for the solar portion of the project at below $0.03/kWh.

The project calls for a 100 MW solar array and a 30 MW, 120 MWh energy storage system, both developed by an affiliate of NextEra Energy. If the pricing proves accurate, it would represent a major cost reduction for combined storage facilities since the signing of the last significant PPA — a $0.11/kWh Hawaii contract in January 2018.

The PPA would confirm a forecast in Arizona's proposed "Clean Peak Standard" that solar-plus-storage facilities could compete with gas peakers on price. But TEP does not support the proposal, now on hold with regulators.

SOURCE: http://www.utilitydive.com/news/updated-tucson-electric-signs-solar-storage-ppa-for-less-than-45kwh/443293/

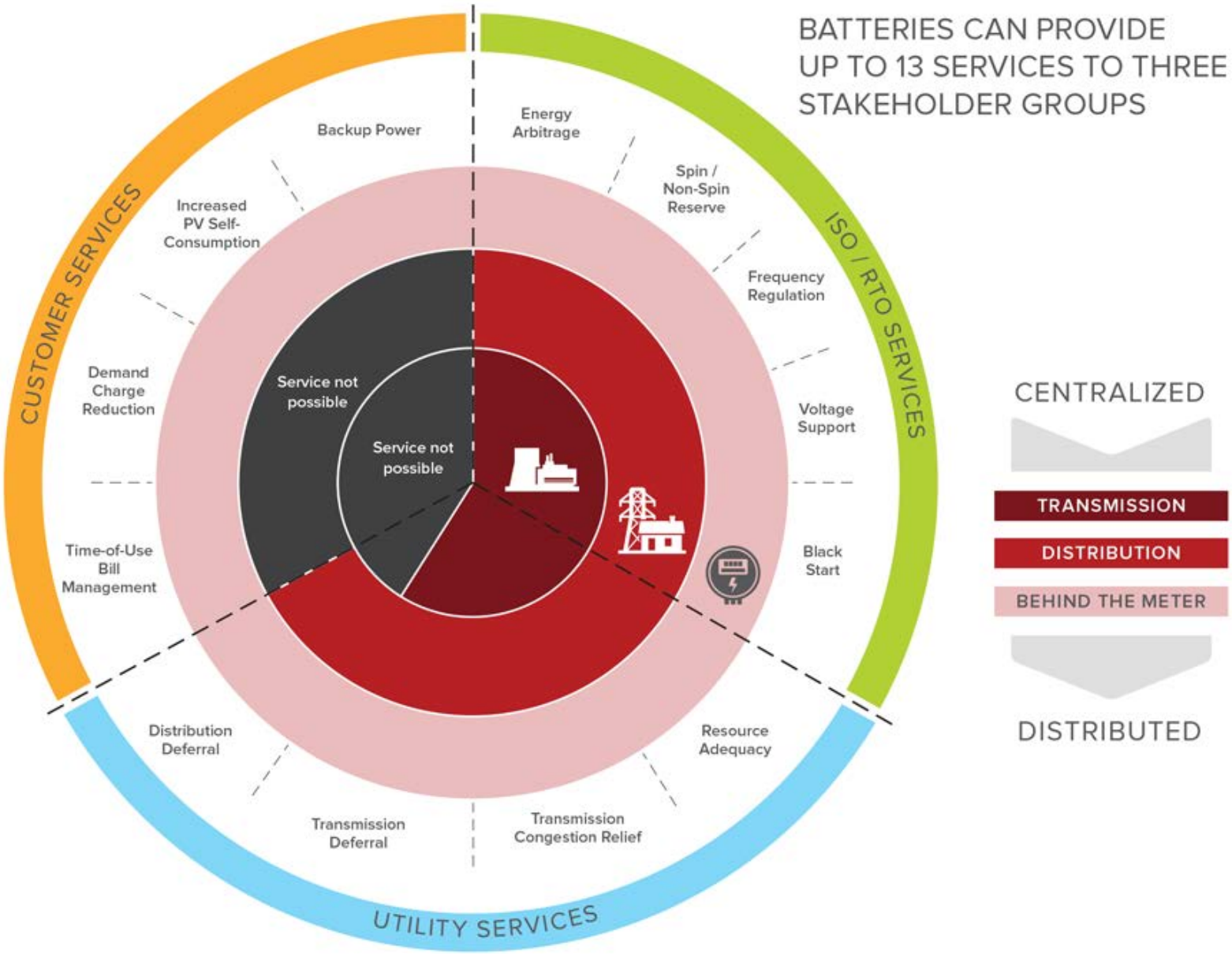
Five years ago, a mere 0.34 GW of energy storage could be found globally. Fast forward and the market is expecting 6 GW to be installed in 2017 alone. Globally, analysts expect the energy storage market to grow 47 percent in 2017 over 2016 installations.

Study Finds It Could Be Cost Competitive with Standalone PV Installations by 2020

A recent NREL technical report examines the benefit of a battery energy storage system (BESS) when paired with a utility-scale solar photovoltaic (PV) system. The report examines both separately installed systems and systems that integrate the PV and BESS components to work together. Although the current high price of batteries causes all combinations with a BESS to have a lower benefit-to-cost ratio than a PV system alone, the best-performing choice is a direct-current system where the BESS is used only to store solar energy, thus qualifying the system for the investment tax credit. The report, titled *Evaluating the Technical and Economic Performance of PV Plus Storage Power Plants* by NREL's Paul Denholm, Josh Eichman, and Robert Margolis, also looks to the near future and finds that by 2020, a BESS will likely yield significant additional net benefits to PV developer. The report, which is summarized in a slide deck**,** was covered by Utility Dive and Greentech Media.

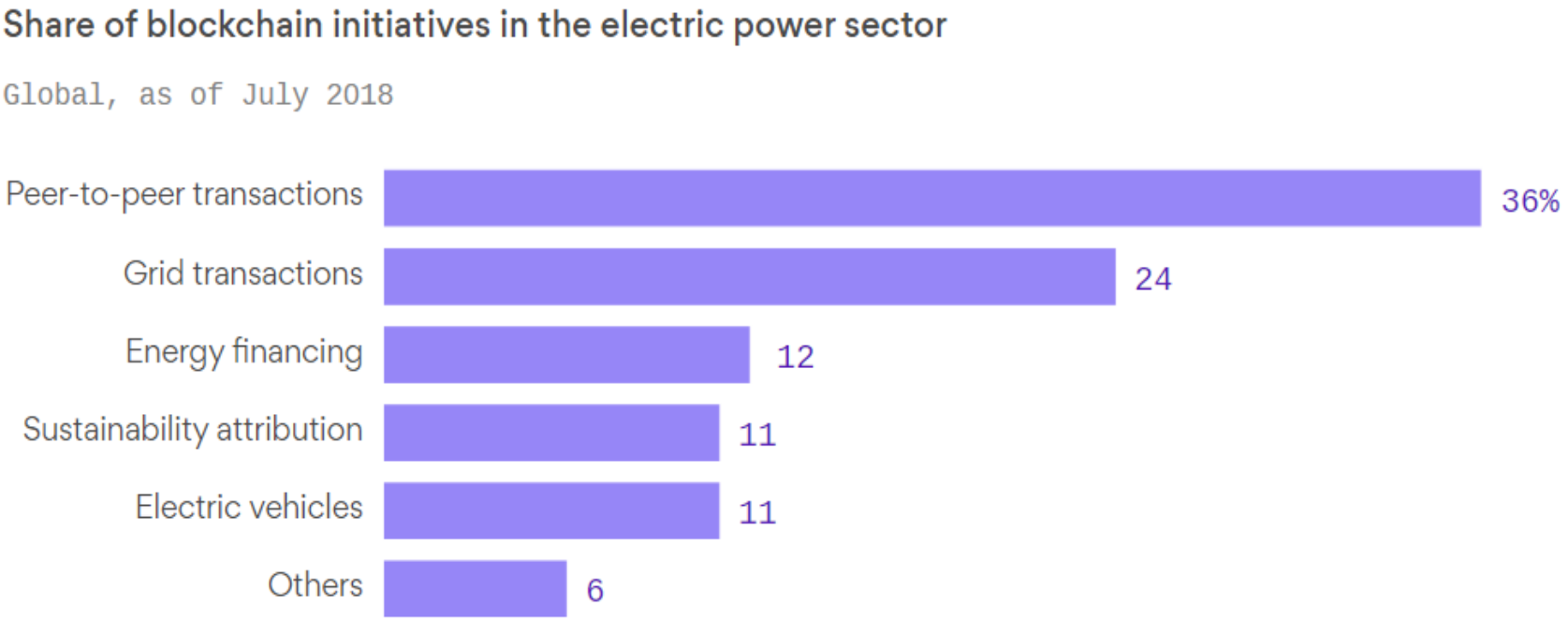
http://www.renewableenergyworld.com/articles/print/volume-20/issue-5/features/energy-storage/a-brief-history-of-utility-scale-energy-storage.html
cmpid=enlrew_energy_storage_news_2017-09-21&email_address=SOLARSKLAR@AOL.COM&eid=291124330&bid=1872394

BATTERIES CAN PROVIDE UP TO 13 SERVICES TO THREE STAKEHOLDER GROUPS



Where blockchain will really matter in energy
Axios

Morning Consult Tue, Jul 31, 2018 8:46 am



Adapted from Livingston et al., 2018, "Applying Blockchain Technology to Electric Power Systems"; Chart: Axios Visuals

POWER QUALITY

(c) Harmonics. In 60 Hertz electric power systems, a harmonic is a sinusoidal component of the 60 Hertz fundamental wave having a frequency that is an integral multiple of the fundamental frequency. "Excessive harmonics," in this subsection, shall mean levels of current or voltage distortion at the point of common coupling between the electric utility and the customer outside the levels recommended in the IEEE standard referenced in paragraph (1) of this section. Each electric utility shall assist every customer affected with problems caused by excessive harmonics and customers affected in exceptional cases as described in paragraph (5) of this section.

(1) Applicable standards. In addressing harmonics problems, the electric utility and the customer shall implement to the extent reasonably practicable and in conformance with prudent operation the practices outlined in IEEE Standard 519-1992, IEEE Recommended Practices and Requirements for Harmonic Control in Electric Power Systems, or any successor IEEE standard, to the extent not inconsistent with law, including state and federal statutes, orders, and regulations, and applicable municipal regulations.

(2) Investigation. After notice by a customer that it is experiencing problems caused by harmonics, or if an electric utility otherwise becomes aware of harmonics conditions adversely affecting a customer, the electric utility shall determine whether the condition constitutes excessive harmonics. If so, the electric utility shall investigate and determine the cause of the excessive harmonics.

https://www.puc.texas.gov/agency/rulesnlaws/subrules/electric/25.51/25.51.pdf

http://www.surgeassure.com/prod.aspx?prod=S50A

S50A surge protector
UL 1449 3rd Edition listed Type 1 Surge Protective Device
Versatile Tri-Mount Installation
10 Year product warranty
The surge**assure**™S50A shields motor-driven appliances in residential and light commercial applications against electrical power surge damage from entering through the main electrical service panel

Early adopters of fuel cells are driven by the need for uninterrupted, high quality power.

Power Disruption Events per Month

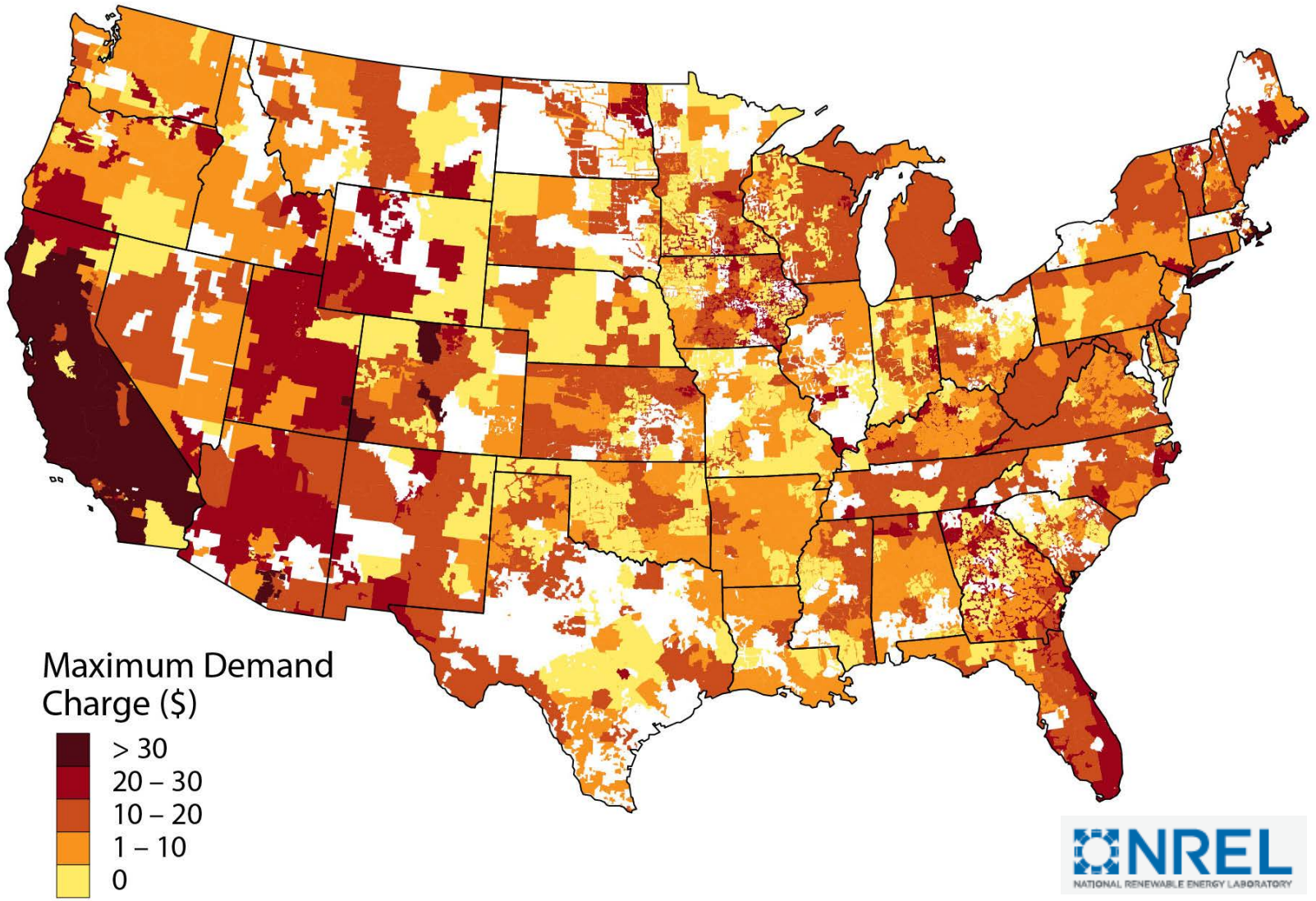
Event	Median	Average	Worst
Interruptions	1.0	1.3	10.0
Sags / undervoltages	4.1	27.9	1,660
Swells / overvoltages	3.4	13.9	1,450
Transients	15.7	63.5	1,166

Source: Duke Power, Sandia National Laboratories

- Power disruptions may cause sensitive equipment to fail.
- As a result, organizations face potential for significant losses – lost data, lost materials, lost productivity, and lost income – as well as risks to public safety.
- A study by Sandia National Laboratories estimates losses from power disruptions at more than $150 billion per year in the U.S.
- In response, more and more organizations are turning to on-site generation to boost power availability.

Nexus Associates, Inc.

Figure 2. Maximum demand charge rates by utility service territory.



Demand Charges Can Vary Widely, Even Within the Same State

Table 3.
Top 10 States with the Most Commercial Customers Estimated to be Eligible for Utility Rates that Include Demand Charges of **$20**/kW or Higher

	Number of Customers Eligible for Demand Charge >$20/kW
California	1,081,000
New York	648,000
Georgia	216,000
Michigan	205,000
Massachusetts	180,000
Kentucky	41,000
New Mexico	24,000
Alabama	23,000
Texas	23,000
Iowa	23,000

http://www.cleanegroup.org/wp-content/uploads/NREL_BatteryStorage_2017.pdf

Maryland's Governor Hogan has signed into law a state income tax credit for specific costs related to energy storage systems installed between January 1, 2018 and December 1, 2022. Systems eligible for the credit are systems that are used to store electrical, mechanical, chemical or thermal energy that was once electrical energy to be used as electrical energy at another time or in a process that would offset electrical use at peak times of electrical use.

The credit applies to both residential and commercial installation. The credit for residential installation is $5,000.00. The credit for commercial installation is the lesser of $75,000.00 or 30% of the cost of the system.

There is a $750,000.00 aggregate cap statewide for the credit, and a taxpayer that wants to utilize the credit must obtain a credit certificate from the Maryland Energy Administration prior to taking the credit. Also, the credit must be taken in the year of the installation, is not subject to a carry forward and cannot exceed the state tax due for that year. The credit is granted on a "first come – first served" basis. The Comptroller is responsible for the promulgation of regulations in relation to the credit.

http://www.jdsupra.com/legalnews/maryland-new-tax-credit-for-energy-22613/

MARYLAND ....System Specs | 402.3 kW
System Production | 515,790 kWh annually
Environmental Benefits | Offsets CO_2 from 41,168 gallons of gasoline annually

The Konterra Solar Microgrid project in Laurel, Maryland is one of the nation's first commercial scale solar grid-interactive battery storage systems. A true game changer for the solar PV industry, the Konterra Solar Microgrid project was developed through a partnership with Konterra Realty, Standard Solar Inc. (SSI), the Maryland Energy Administration (MEA), and Solar Grid Storage (SGS). The project consists of a 402.3kW solar canopy, a 300kwh commercial scale back-up battery system, and two electric vehicle charging stations with infrastructure for four additional stations. This innovative clean energy generation technology produces 515,790kWh annually and offers new benefits such as battery back-up against grid outages, which provides solar powered energy for critical loads.

Note: Standard Solar (MD) is adding storage to a nearly 4 MW project recently completed at Fort Indiantown Gap near Harrisburg PA. 2/2019

https://www.standardsolar.com/about-us/projects/konterra-solar-microgrid-project

Batteries Are Coming to North Carolina, But How Many, How Soon Depends on Policy:

Energy News, by Elizabeth Ouzts, January 8, 2019

https://energynews.us/2019/01/08/southeast/study-batteries-are-coming-to-n-c-but-how-many-how-soon-depends-on-policy

Analysts say that batteries already make economic sense for certain uses today in North Carolina, and that if trends continue, by 2030, 5 gigawatts of large-scale battery storage will be well worth the investment. Five gigawatts would be enough to displace numerous fossil gas plants. Today North Carolina has about 1 megawatt of battery storage, mostly in the form of microgrids. In October, Duke Energy announced it would build 300 megawatts of battery storage in both Carolinas over the next 15 years. However, that lags behind those in regions where there's competition in the electricity marketplace and an independent, multi-state grid management organization. The PJM distribution market, for example, which covers the Mid-Atlantic and parts of the Midwest, already boasts 278 megawatts of battery storage.

Demand Charge Savings from Commercial Solar

Authors:
Naïm R. Darghouth; Galen L. Barbose; Andrew D. Mills; Ryan H. Wiser;
Pieter Gagnon; Lori Bird

Date Published:
07/2017

Abstract: Commercial retail electricity rates commonly include a demand charge component, based on some measure of the customer's peak demand. Customer-sited solar PV can potentially reduce demand charges, but the magnitude of these savings can be difficult to predict, given variations in demand charge designs, customer loads, and PV generation profiles. Moreover, depending on the circumstances, demand charges from solar may or may not align well with associated utility cost savings.

Lawrence Berkeley National Laboratory (Berkeley Lab) and the National Renewable Energy Laboratory (NREL) are collaborating in a series of studies to understand how solar PV can reduce demand charge levels for a variety of customer types and demand charges designs. Previous work focused on residential customs with solar. This study, instead, focuses on commercial customers and seeks to understand the extent and conditions under which rooftop can solar reduce commercial demand charges. To answer these questions, we simulate demand charge savings for a broad range of commercial customer types, demand charge designs, locations, and PV system characteristics. This particular analysis does not include storage, but a subsequent analysis in this series will evaluate demand charge savings for commercial customers with solar and storage.

https://emp.lbl.gov/sites/default/files/comdemandcharge-execsummary.pdf
https://emp.lbl.gov/sites/default/files/comdemandcharge-briefing.pdf

U.S. Army Invests in 1-Megawatt Energy Storage System to Complement 10-Megawatt SunPower Solar Power Plant at Redstone Arsenal:
North American Clean Energy, August 23, 2017

http://www.nacleanenergy.com/articles/28093/u-s-army-invests-in-1-megawatt-energy-storage-system-to-complement-10-megawatt-sunpower-solar-power-plant-at-redstone-arsenalhttp://www.nacleanenergy.com/articles/28093/u-s-army-invests-in-1-megawatt-energy-storage-system-to-complement-10-megawatt-sunpower-solar-power-plant-at-redstone-arsenal

SunPower Corp. has broken ground on a 10-megawatt solar photovoltaic system at the Redstone Arsenal U.S. Army post in Alabama. With a newly added 1-megawatt energy storage system, the project is designed to strengthen energy security and resilience at Redstone Arsenal. The innovative project was financed by a power purchase agreement, allowing the Army to buy 100 percent of the power generated without having to pay for the power plant's construction, maintenance and operation.

US Army Installs Largest Battery Storage System

US Army Installs Largest Battery Storage System

August 27, 2018 by Nicholas Nhede, Smart Energy International

The US' largest stand-alone battery energy storage system ever to be developed at an army base is being installed at Fort Carson, El Paso County in Colorado.

The project is part of an energy savings performance contract signed between the US Army, infrastructure development firm AECOM and technology provider Lockheed Martin.The 4.25MW/8.5MWh lithium battery energy storage system is expected to help reduce energy demand during peak intervals and reduce the base's energy costs. Lockheed Martin Energy, said: "The versatility of energy storage is a key enabler for the military's aggressive goals of achieving energy resiliency." The plant will help the base to optimize its solar photovoltaic assets and will be used for microgrid support. Lockheed Martin's energy storage batteries will be integrated with predictive analytics software developed by Growing Energy Labs to enable real-time operation, monitoring and management. The revenue-generating system will operate behind Fort Carson's electric utility meter.

+++

Source: https://www.renewableenergyworld.com/articles/2018/08/us-army-installs-largest-battery-storage-system.html?cmpid=enl_rew_energy_storage_news_2018-08-29&pwhid=3cf9a21d4d81e0aea476e2322be758a3f411304d216c3dd1b50901a8f4bba6e4ee73b9096927f9fd43ffb0c49bbb3348543dd7c6eac631fcbc4cad903ccc0a43&eid=291124330&bid=2222176

TYPES OF PROJECTS OVER THE LAST 15 YEARS.....

- Net Zero Energy building – Washington Navy Yard, DC

- Two zero energy buildings – totally off-the-grid in Arlington, VA
  127 buildings worldwide

- Critical infrastructure project – Davis-Monthan AFB, AZ

- AxionPower one MW battery bank on PJM Grid, PA

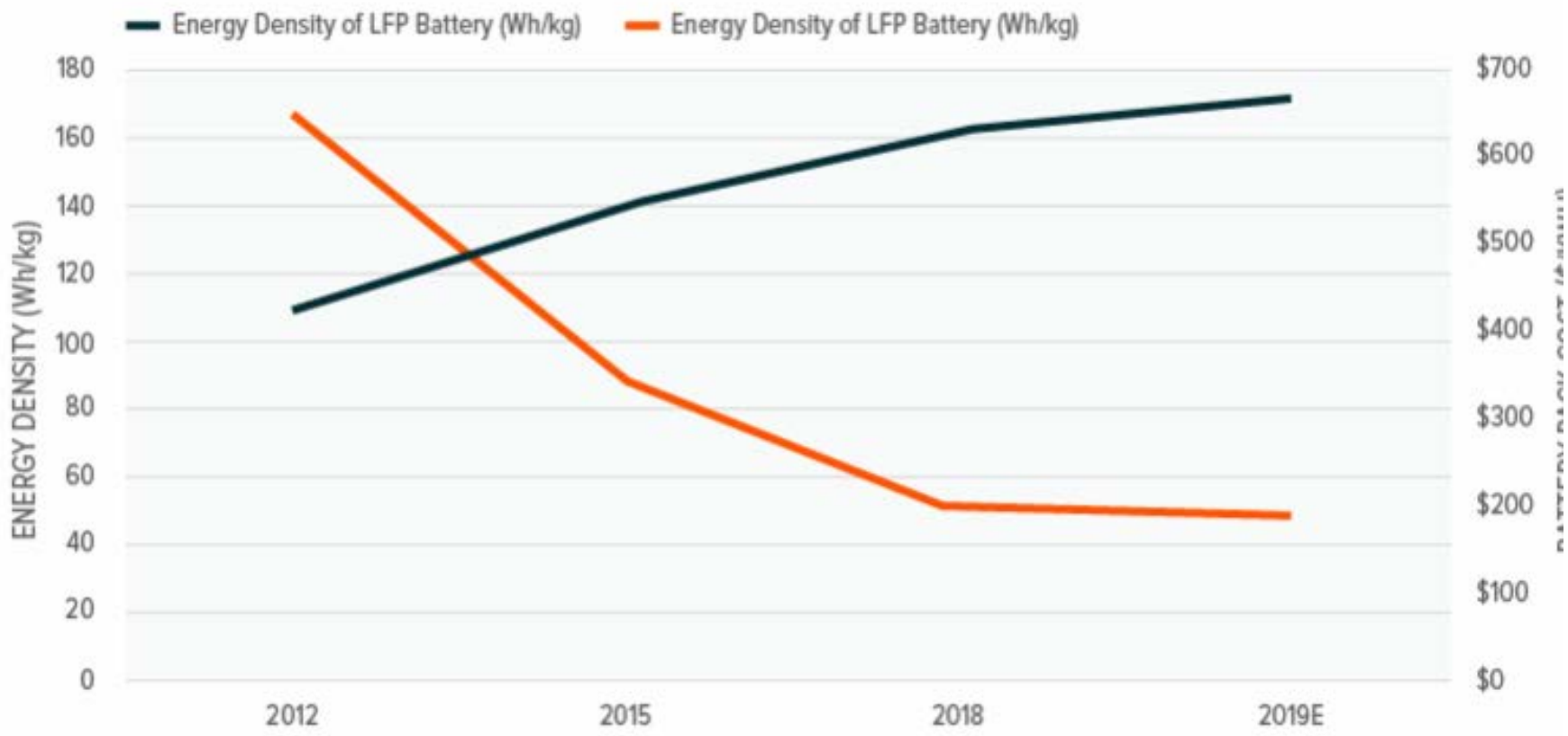
- APS one MW battery bank by AES, AZ

- Cell towers – totally on-site RE DG with battery banks in
  Morocco, AZ, West Africa

- Various projects during and post Katrina in MS and LA
  working for Gov of MS, and CCI for New Orleans

BATTERY IMPROVEMENTS OVER TIME

Source: BYD, Bloomberg NEF, CairnERA



2/2019

Updated: Tucson Electric signs solar + storage PPA for 'less than 4.5¢/kWh'

AUTHOR
Gavin Bade@GavinBade
Peter Maloney@TopFloorPower

PUBLISHED
May 23, 2017

Dive Brief:

Tucson Electric Power has signed a power purchase agreement for a solar-plus-storage system at "an all-in cost significantly less than $0.045/kWh over 20 years," according to a company official. Exact prices are confidential, but a release pegged the PPA for the solar portion of the project at below $0.03/kWh. The project calls for a 100 MW solar array and a 30 MW, 120 MWh energy storage system, both developed by an affiliate of NextEra Energy. If the pricing proves accurate, it would represent a major cost reduction for combined storage facilities since the signing of the last significant PPA — a $0.11/kWh Hawaii contract in January.

SOURCE:
http://www.utilitydive.com/news/updated-tucson-electric-signs-solar-storage-ppa-for-less-than-45kwh/443293/

Key State Regulatory and Legislative Energy Storage Policies and Actions

(As of Q3 2016)

Oregon
- PGE 2016 IRP
- Energy Storage Program UM 1751
- $300K from ODOE for Energy Storage Projects
- PGE storage included in RFP UM 1535
- HB 2193

Washington
- Valuing Energy Storage UE-151069
- $14.3 MM from Clean Energy Fund 1 and $12.6 MM from Clean Energy Fund 2
- UTC request for storage as resource option in future IRPs UE100961
- HB 1115

Minnesota
- Grid Modernization Investigation 15-556
- HF 3

New York
- Reforming the Energy Vision 14-M-001
- DSIPs 16-M-0411
- BCA Handbooks 16-M-0412
- Value of DER 15-E-0751
- NYC Storage Target 100 MWh by 2020
- CEF Energy Storage Chapter
- ConEd Peak Load Reduction Program
- BQDM peak reduction RFP 14-E-0302
- PSEG-LI peak reduction RFP

NYISO
- DER Roadmap
- Storage Market Integration and Optimization Initiative

Vermont
- GMP and Tesla BTM Storage Pilot
- HB 40

New Hampshire
- Grid Modernization IR 15-296

Massachussets
- $10 MM DOER Energy Storage Initiative
- Conference on Energy Storage 15-ESC-1
- H 4568
- S 1770
- S 1762

California
- Energy Storage Framework and Procurement R1503011
- SGIP Program R1211005
- DRP R1408013
- Integrated DER R1410003
- Demand Response R1309011
- Aliso Canyon Storage RFO
- SB 350
- AB 33
- AB 2868
- AB 1637
- AB 2861

Nevada
- Battery Storage Investigation 16-01013
- Governor's Clean Energy Task Force

Iowa
- MidAmerican Community Solar and Storage Pilot NOI-2014-0001

District of Columbia
- Grid Modernization FC1130

Connecticut
- Investigation into Energy Storage 15-11-34
- Draft Energy Storage RFP
- Demonstration Projects
- DEEP Microgrid Grant Program
- SB 272
- SB 1078
- SB 1502

Maryland
- Technical Conference on DER Policies
- Grid Modernization: PC44

Utah
- SB 0115

Colorado
- Innovative Clean Technology Projects Program
- PNM 2011 IRP storage as supply-side resource 11A-869E

New Jersey
- $6 MM Renewable Electric Storage Incentive Program
- Town Center Microgrid Program
- S 2016

New Mexico
- Renewable Energy Storage Working Group
- Energy Policy & Implementation Plan

Texas
- ONCOR Compressed Air Energy Storage Interconnection 44672
- $1MM New Technology Implementation Grant

North Carolina
- Duke Energy Storage Pilot E-2 Sub 1089
- Interconnection Standards E-100 Sub 101

CAISO
- ESDER Initiative
- Flexible Capacity Procurement
- Flexible Ramping Product
- Expanding Metering and Telemetry Options
- 2015-16 Transmission Planning

Arizona
- APS Energy Storage Pilot and Incentive Program E-01345A-15-0241
- TEP Energy Storage Pilot E-01933A-15-0239
- APS DSM Storage Carveout E-01345A-16-0176
- APS/RUCO Settlement for All-Source RFPs
- Interconnection Standards RE-00000A-076-0609
- ACC Technology workshop
- SRP and ASU Storage Pilot
- SB 1465

Hawaii
- Investigation into DER Policies (Self-Supply NEM) 2014-0192
- HECO PSIPs 2014-0183
- HECO 2013 IRP storage as supply-side resource 2012-0036
- HECO and Stem Storage Pilot
- HECO and Greenlots V2G Pilot
- Integrated DR Portfolio Plan 2007-0341
- HB 2236

ERCOT
- Future Ancillary Services Team (FAST) NPRR677

Georgia
- Value of DER for Georgia Power's 2016 IRP 39732
- Georgia Power Tesla Storage Pilot and Demos 40161

Contact: Coley Girouard, cgirouard@aee.net, 202.309.0647

ADVANCED ENERGY ECONOMY

ESA Energy Storage Associa

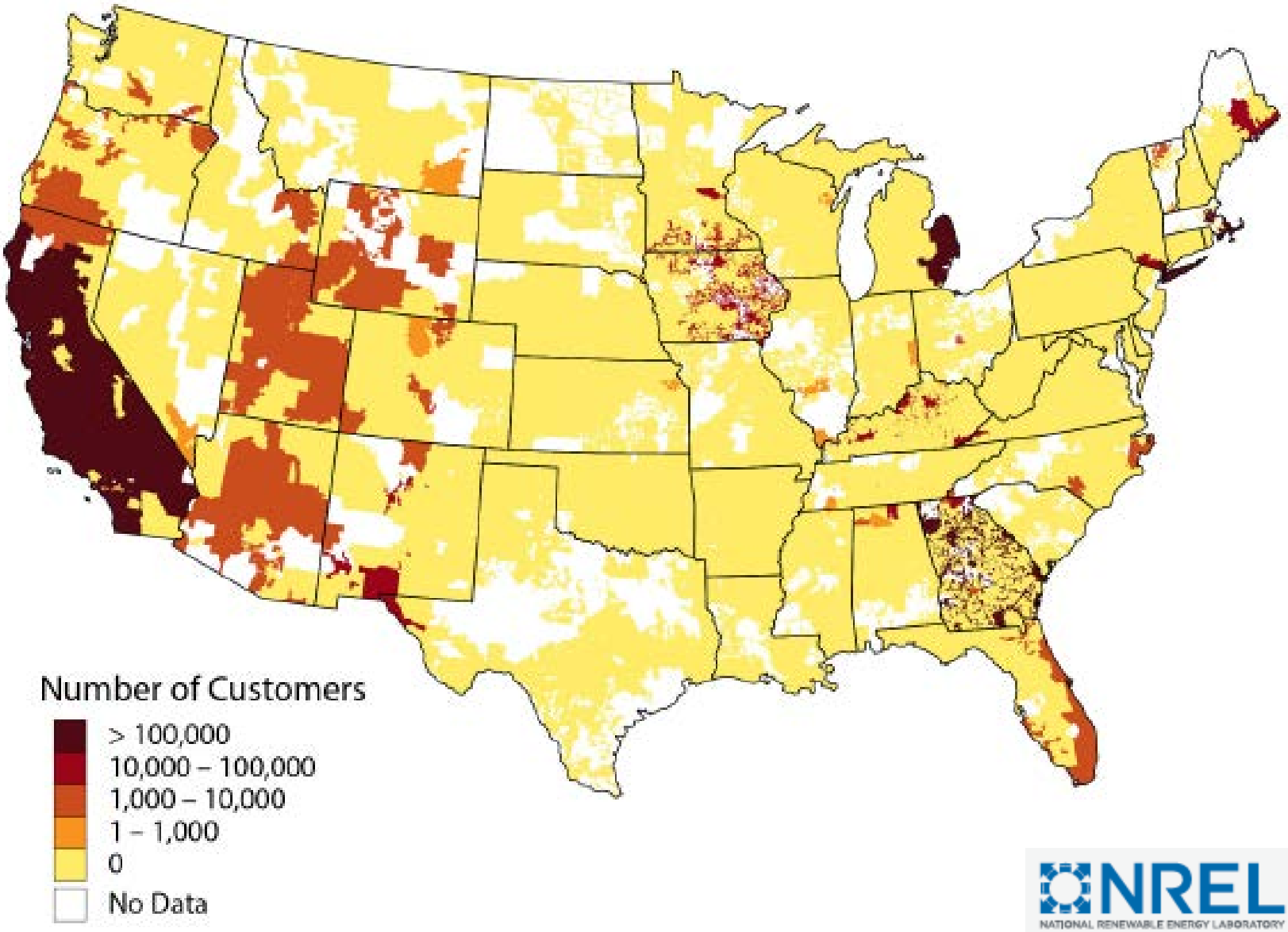
Battery Storage Accelerates Puerto Rico's Transition to a Distributed Energy Grid:

Navigant Research, by Ricardo Rodriquez, August 24, 2018

https://www.navigantresearch.com/news-and-views/battery-storage-accelerates-puerto-ricos-transition-to-a-distributed-energy-grid

The Puerto Rico Public-Private Partnerships Authority and the Puerto Rico Electric Power Authority (PREPA) recently issued a Request for Qualifications (RFQ) for utility scale energy storage projects. The proposal seeks to add nearly 200 MWh of batteries, enough to supply 5% of the island's peak electricity demand, as it rebuilds in the wake of Hurricane Maria. The RFQ calls for 10 20 MW/20 MWh battery electric storage systems to interconnect to 10 115 kV switchyards owned by PREPA. At an estimated cost of $3.8 million each, these systems must also have the flexibility and modularity to expand to 40 MW/160 MWh should the initial rollout prove successful. It is expected that this project will provide net savings of $8 million to $12 million per substation.

Figure 4. Estimated number of commercial electricity customers who can subscribe to tariffs with demand charge in excess of $20/kW.



Massachusetts targets 200 MWh of energy storage by 2020

By

Krysti Shallenberger June 30, 2017

Dive Brief:

Massachusetts must procure 200 MWh of energy storage by January 1, 2020, according to new targets set by the state Department of Energy Resources Friday.

The agency allocated $10 million in funding for demonstration projects and will evaluate the whether storage resources should be allowed to participate in the Alternative Portfolio Standard.

Massachusetts released its highly-anticipated energy storage target a day before its July 1 deadline. The target aims to help the state reach its renewable energy goals including procuring 1,600 MW of offshore wind.

“As the Commonwealth continues to make unparalleled investments in renewable energy, energy storage technologies have the potential to play an integral role in effectively deploying these new resources,” said Gov. Charlie Baker (R) in a statement.

While the number is considerably less than the potential 600 MW, it's still significant for a state with a relatively nascent energy storage market.

SOURCE: http://www.utilitydive.com/news/massachusetts-targets-200-mwh-of-energy-storage-by-2020/446281/

Standardized Interconnections

- 49 States allow DG under IEEE consensus standards which has allowed smart battery banks like the GridPoint 3.6 kw in my VA office building (installed 2006)

- This unit was the first standardized battery bank with charge controller, inverter, dc disconnect and microprocessor w/ modem in top of unit; and 8 250 amp hour AGM batteries in bottom of unit.

- PV and Wind connect to the upper left side of this unit.

ENGION SENTRY

SYSTEM

Function	automatic back-up emergency power, off-grid
Output power (continuous)*	6.8 kW
Overload 30 min / 60 s*	8.5 kW / 12 kW
Input / output voltage AC	120 V
Nominal battery capacity	9.2 kWh / 13.8 kWh / 18.4 kWh
Dimensions (W x H x D) in inches	23.6 x 72.8 x 23.6

INVERTER

Maximum output current 60 s (rms)	102 A (120 V)
Output frequency	60 Hz
Input voltage range DC	42 – 64 V (48 V nominal)
Maximum input current DC	180 A
Maximum output charge current DC	140 A

BATTERY

Electrochemistry of cell	valve Regulated Lead Acid (VRLA)
Design life	10 years
Battery voltage	48 V nominal (4 x 12 V)
Battery capacity C10	192 Ah / 288 Ah / 384 Ah (8 / 12 / 16 batteries)
Dimensions (W x H x D) in inches	4.3 x 9.4 x 20.1 (each 12 V battery)
Weight	75 lbs (each 12 V battery)

SOLAR CHARGE CONTROLLER**

Max. PV array voltage (operating)	140 V
Max. PV array open circuit voltage	150 V including temperature correction factor
Max. charge current	60 A

VARTA Storage GmbH
Emil-Eigner-Straße 1
86720 Nördlingen
Germany

Powerwall comes in 10 kWh weekly cycle and 7 kWh daily cycle models. Both are guaranteed for ten years and are sufficient to power most homes during peak evening hours. Multiple batteries may be installed together for homes with greater energy need, up to 90 kWh total for the 10 kWh battery and 63 kWh total for the 7 kWh battery. (Tesla)

40.7 MW of energy storage was deployed in Q2 2015, a nine-fold increase from Q2 2014, and six-fold increase from Q1 2015. Behind-the-meter market continued its strong showing of previous quarters, and grew over eleven times from same period last year.

http://files.ctctcdn.com/1fb72c5e001/5e784b5b-74ee-4031-88b0-c2ea937bf943.pdf

sonnen

Sonnen's mission is to provide clean and affordable energy for all. As the first mainstream grid tied residential energy storage company in the world and with 24,000 sonnenBatterie systems installed worldwide, sonnen is a proven global leader in intelligent energy management solutions. The all-in-one sonnenBatterie smart energy storage solution easily integrates with new and existing solar installations to help homes manage their energy throughout the day-saving money, providing backup power, and maximizing the effective use of solar power day and night. Sonnen has won several awards for its energy innovations, including the 2017 Zayed Future Energy Prize, MIT's Technology Review's 50 Smartest Companies in 2016, Global Cleantech 100 for 2015-2017

LG rolled out new battery products at the 2018 Solar Power International Conference this week in California: a 5 kW AC-coupled system for homes where solar panels are already installed and a 7.6 kW DC-coupled system for new installations. (9/26/2018)

https://www.utilitydive.com/news/as-residential-energy-storage-booms-lg-enters-market-with-expandable-batte/533123/

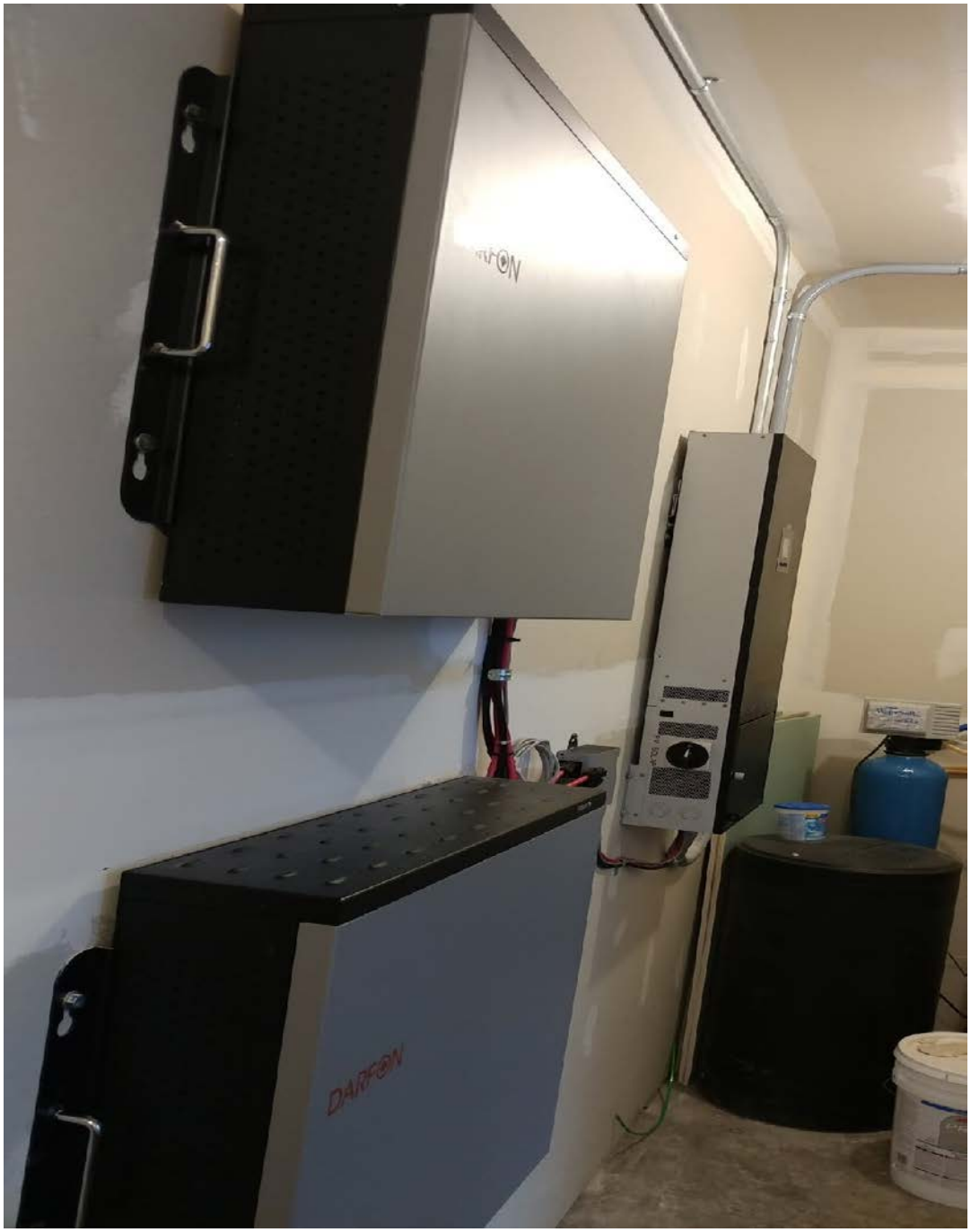
2018-03-21 - With its modular design, ABB’s new solar inverter with energy storage capability, REACT 2, provides a capacity of up to 12 kWh, increasing electric self-sufficiency of homes.

http://www.abb.com/cawp/seitp202/B2A53C2AB2AFE7F6C125825700315D59.aspx

Distributed Energy Storage System L1000 In-Building

Manage energy use, cut costs and provide backup power for a building, campus or enterprise with the L1000 In-Building Distributed Energy Storage System from Johnson Controls. We combine world-class battery technology, in-depth buildings expertise and intelligent controls to deliver the solution that performs best with your specific building systems. Controls go beyond the battery to optimize whole-building performance and simplify participation in energy markets. Adaptive algorithms and premium battery composition help realize the lowest total lifecycle cost.


Energy Monitor
OUTSIDE TEMP 23 °F
ENGINE
BATTERY
ELEC. MOTOR
Consumption
Current 99.9 MPG



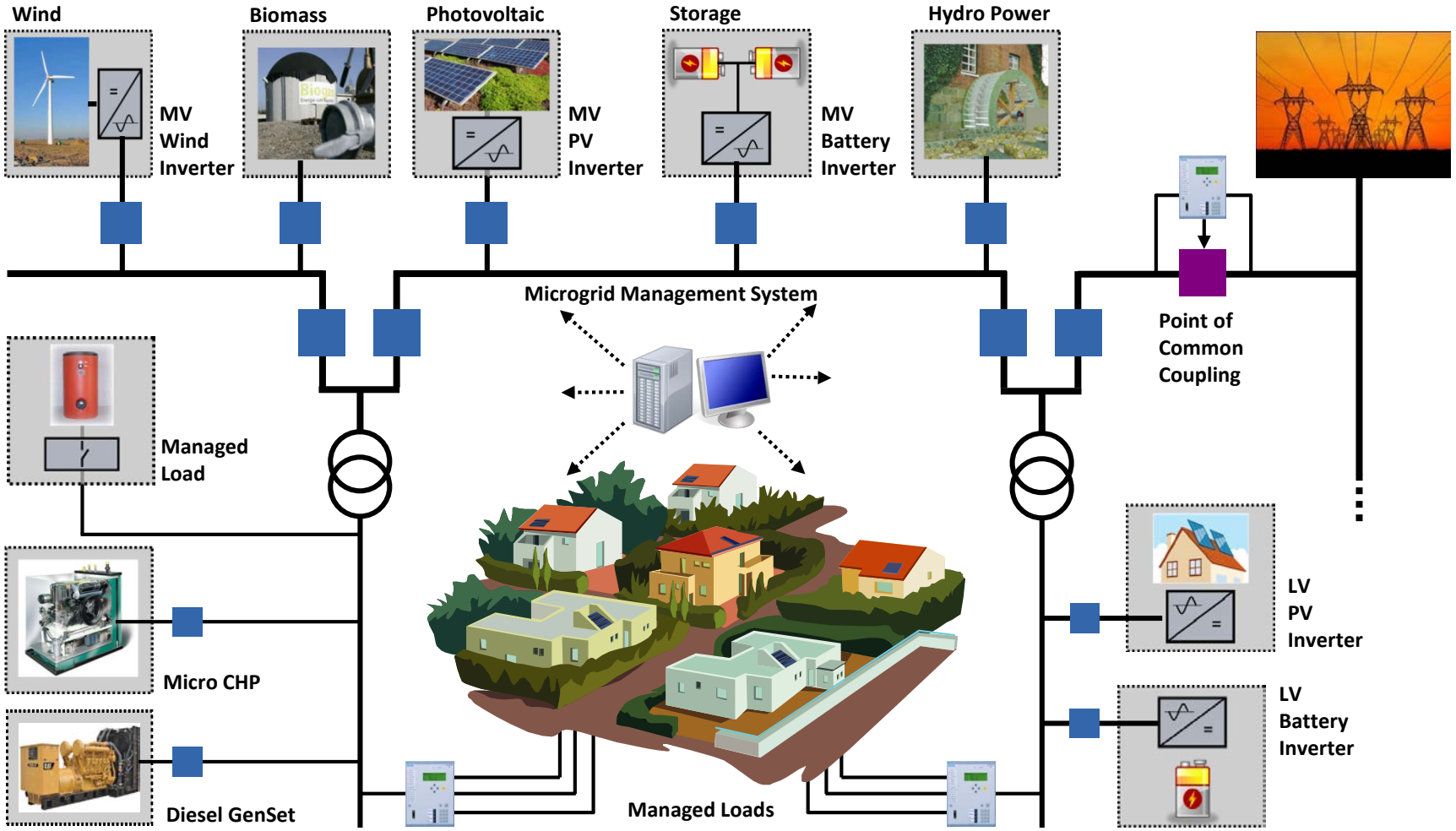
'clean' installation of the Darfon 12kW Lithium battery system with 7.5kW PV in Moorefield, W VA

Ben Glenzer Solar Solutions For All

http://solarsolutionsforall.com/projects--customer-testimonials.html


NUVATION BMS™
System status
Stack Voltage
42.0 V
Stack Current
0.57 A
100%
System statistics
cell voltage
cell temperature
NUVATION
ENGINEERING

Microgrids for Mission Critical Installations



Lockheed Martin, ComEd Team Up for Chicago Microgrid with Solar, Battery Storage:
Solar Industry Magazine, by Betsy Lillian, May 15, 2018

https://solarindustrymag.com/lockheed-martin-comed-team-up-for-chicago-microgrid-with-solar-battery-storage

Lockheed Martin has signed an agreement to supply a GridStar Lithium energy storage system to ComEd, Illinois' largest electric utility and a unit of Exelon. The 2 MWh system will be integrated into ComEd's Bronzeville community microgrid project in Chicago. The microgrid will include battery storage and solar power. It will be connected to a microgrid on the campus of the Illinois Institute of Technology, creating the first utility-operated microgrid cluster in the nation. It is expected to serve more than 1,000 customers, including critical service providers such as the Chicago Police Department. The microgrid is expected to be completed in 2019.

EDF Renewable Energy has created a new subsidiary for distributed solar and storage projects up to 30 MW.

EDF creates U.S.-based storage unit
By Emiliano Bellini on Mar 16 2017, 2:39pm

https://pv-magazine-usa.com/2017/03/16/edf-creates-u-s-based-storage-unit/

Kaua'i to meet 1/4 of power needs with solar thanks to Tesla system

By Christian Roselund on Mar 10 2017, 2:50pm

Today Tesla will officially put online its solar-PV-plus-storage project on the island of Kaua'i, at the end of Hawaii's chain of islands. The 13 MW solar and 52 MWh battery storage project will supply electricity under a 20-year contract with the island's public utility. Unique among utility-scale PV systems, Tesla's project will be used to meet peak demand between 5 PM and 10 PM – after the sun goes down. This will be accomplished through the use of the battery system, which is comprised of 272 Tesla Powerpack batteries using lithium-ion technology developed by Panasonic in collaboration with Tesla.

Cellular Tower and Repeater Power

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The ZeroBase ReGenerator is:

Portable

Environmentally-sealed, marine-grade housing

Hybrid

Manages up to 10kW of production & storage

Power Generation

Distributed power generation from solar, wind & fossil-fuels

Storage

Stores up to 43kWh in sealed AGM batteries

Appliance

Easy set-up, simple to operate and maintain
COTS since 2007 – In-theater since 2008
Mounts to standard TQG trailers

PJM's frequency response market adds 31.5MW of Invenergy's renewables storage in Illinois May 15, 2015 9:49

Tesla Finishes Building World's Largest Battery Month and a Half Ahead of Schedule

Elon Musk has won an audacious bet he made back in March to build a battery system for South Australia in “100 days from contract signature or it is free.” The 100-megawatt Powerpack system is the world's largest. Tesla CEO was responding to a challenge from Australian IT billionaire Mike Cannon-Brookes to help fix the Australian state's electricity woes. Losing the bet would have cost Musk probably $50 million or more.” The grid connection deal was finally signed on Sept. 29—kick-staring the 100-day clock—Tesla was already halfway finished with installation. So if you want to be technical, you could say that the project was finished a month and a half before the contract's deadline. The company originally estimated completion by December 2017. The lithium-ion battery storage facility will be charged by Neoen's Hornsdale wind farm near Jamestown, South Australia and deliver electricity during peak hours. According to Business Insider, when fully charged, the battery should hold enough power for 8,000 homes for 24 hours, or more than 30,000 houses for an hour during a blackout.

https://www.ecowatch.com/tesla-worlds-largest-battery-2512145319.html

Hawaii's largest solar array, complete with storage, now online

by Robert Walton | November 3, 2015

REC Solar has brought online Hawaii's largest solar array yet, a 12 MW (AC) facility paired with a 6 MW lithium ion battery system, PV Magazine reports. Developed for Kauaʻi Island Utility Cooperative (KIUC), the system is located on 60 acres and will supply 20% of the island's annual power needs. The solar plant will help the island meet its goal of 38% renewables by the end of 2015, on the road to hitting the statewide 100% renewables target by 2045.The solar power will allow KIUC to cut fossil fuel imports and will save $250,000 each month on operating costs alone, according to the company.

SOURCE:
http://www.utilitydive.com/news/hawaiis-largest-solar-array-complete-with-storage-now-online/408472/

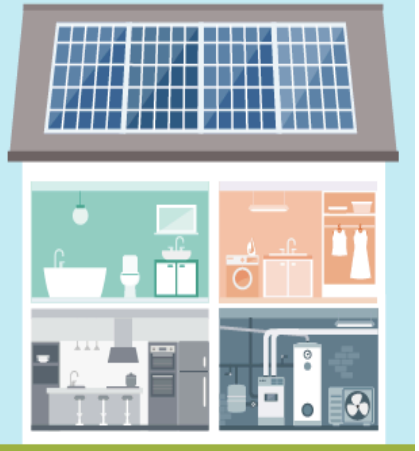
Alevo Set to Deliver First GridBank Providing Ancillary Services to PJM*First commercial unit will be one of three sites in Hagerstown, MD totaling 12 MW*

Alevo Group, the Energy Storage Provider, today announced that its first GridBank™ storage unit has been cleared for shipping and installation after completing an extensive factory acceptance testing (FAT) process at Parker Hannifin's Energy Grid-Tie Division. Alevo and Parker Hannifin have collectively conducted a series of validation and application tests on the 2MW/1MWh unit to verify the GridBank's performance based on safety, power, thermal stability, communications, response rates and ability to deliver specific applications.

The Solar Plus Home

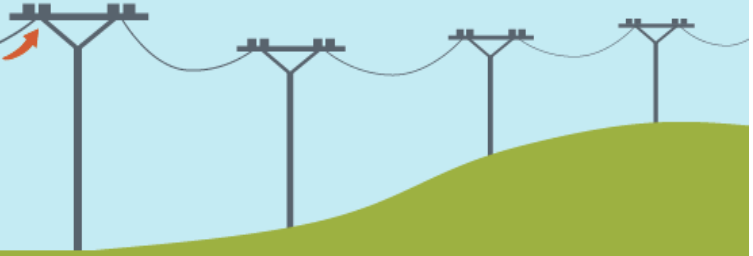
Solar panels generate energy during the day, when most homeowners are not home

There are a number of controllable appliances, like hot water heaters and air conditioners, that can be used to store energy during the day



With the addition of EVs and batteries, even more of that energy can be stored

Solar Plus looks at how more energy can be used in the home, which helps utilities better manage the grid



RECENT ENERGY STORAGE STUDIES

CALIFORNIA
http://www.cpuc.ca.gov/NR/rdonlyres/1110403D-85B2-4FDB-B927-5F2EE9507FCA/0/Storage_CostEffectivenessReport_EPRI.pdf

TEXAS
http://www.brattle.com/system/news/pdfs/000/000/749/original/The_Value_of_Distributed_Electricity_Storage_in_Texas.pdf

FERC – DG
The potential benefits of distributed generation and rate ...
https://www.ferc.gov/legal/fed-sta/exp-study.pdf

THE POTENTIAL BENEFITS OF DISTRIBUTED GENERATION AND RATE-RELATED ISSUES THAT MAY IMPEDE THEIR EXPANSION
A STUDY PURSUANT TO SECTION 1817 OF THE ENERGY POLICY ACT OF 2005

THERE ARE NO DUMB QUESTIONS !!!

SCOTT SKLAR

solarsklar@aol.com